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13. ABSTRACT (Maximum 200 words)  While there were many changes made in the ration components and menus of the Meal-Ready-to-Eat (MRE) during the period from 1988 to 1999, the changes did not have a great impact on the nutrient content of the ration. This report discusses each of 31 nutrients in the MRE VIII - XIX meals and how these nutrients met the Nutritional Standard for Operational Rations (NSOR). Magnesium, zinc and folate, which fell slightly below the NSOR in some versions of the ration, should be considered as part of the fortification in future MREs. It also emerged that the fat content of the ration has had a tendency to rise because of the increasing number of fat-containing spreads in the ration. Because this trend can be pinpointed to one group of foods, it could be corrected by decreasing the number of occurrences or package weight of these items. In a comparison to an old research study, this paper also demonstrates how the consistency of nutrient data used over time needs to be controlled in order to draw the right conclusions regarding a ration.				
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**NUTRIENT CONTENT OF THE  
MEAL, READY-TO-EAT  
1988 - 1999**

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February 2002

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## **DISCLAIMER**

The opinions or assertions contained herein are the private views of the author and are not to be construed as official or as reflecting the views of the Army or the Department of Defense.

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## **INTRODUCTION**

The Meal, Ready-to-Eat (MRE) is the current standard operational ration for the individual U.S. military warfighter in the field. It contains food components that are ready to eat and require no preparation except for the reconstitution of the powdered beverages. Packaging is designed to be lightweight, flexible and suited for portability. MRE meals are packed 12 to a case to provide a variety of menus, interchangeable for breakfast, lunch and dinner. The first version of the ration, MRE I, was fielded in 1981, with other versions of the ration produced each following year.

Feedback obtained during field tests on MRE I - VII resulted in major changes being implemented in later components and menus. When MRE VIII was fielded, two-thirds of the entrees found in MRE I - VII had been eliminated, including the two freeze-dried entrees (beef and pork patties). The weight of most of the combination entrees had also stabilized to 8 ounces by 1988, whereas in previous MREs (I - VII), many of the entrees began as 5-ounce servings. After MRE V, the freeze-dried potato patties had also been eliminated, leaving the fruits as the only freeze-dried items in MRE VIII - XV. After MRE VII, the candies were from commercial sources rather than military specification items. Through MRE XV, there were 12 menus in the ration. Beginning with MRE XVI, the number of menus increased to 16. MRE XVII had 20 menus, and all later versions of the MRE had 24 menus.

This paper will concentrate on the nutrient content of MRE VIII - XIX. As stated above, MRE VIII was quite different from earlier versions of the ration. Likewise, the nutrient data provided for MRE XX will be from a different source than earlier data because it will be provided by the manufacturers and generated from a computer program. In contrast, the nutrient data for components of MRE VIII - XIX were mainly obtained from laboratory analyses funded by the government. Thus, the data for this report consist of mainly laboratory-analyzed data, and the principles used in developing the nutrient database for this report were consistent. Finally, the same Nutritional Standard for Operational Rations (NSOR) has been used since 1985, and it is appropriate to compare these MRE data to this standard. Therefore, this report should be reliable for indicating trends in the nutrient content of the MRE from 1988 - 1999 and will recommend improvements for future versions of the ration. While the data presented in this paper evaluate the ration as planned, not as consumed, the paper will also point out why researchers must be aware of what nutrient database is being used to analyze reported studies.

## **NUTRIENT DATABASE**

The nutrient data being presented were derived from the Natick/USARIEM Nutrient Database for Military Operational Rations, Third Edition, 1999 (7), developed as a joint effort between the Combat Feeding Directorate at the Natick Soldier Center (NSC) at the United States Army Soldier and Biological Chemical Command and the Military Nutrition Division at the United States Army Research Institute of Environmental



Medicine (USARIEM). Over the years, NSC managed the contracts and the in-house laboratory used to determine the nutritional content of the MRE components. From 1971 - 1993, the Combat Feeding Directorate maintained a nutrient database on mainframe computers. In 1993, USARIEM converted the database to the database management system Paradox (4) on a personal computer. Fields were added to the old format (e.g., to identify the source of the information). After compilation, a committee reviewed the data for each component. Although only 31 nutrients were reviewed, other nutrients (e.g., selenium) were included in the database for future reference. A computerized nutritional analysis program (2,3) was used to analyze the formulations (recipes) for each food component, whether derived from the military specification for earlier components, or from the ingredient statement on the nutrition facts label for later components. If laboratory values were not available and therefore had not been entered into the database for one or more of a component's nutrients, a value was imputed for the missing value(s) to complete the profile of 31 nutrients. The following were used as guidelines for imputing the missing values: analyses which indicated values less than the laboratory's detectable limit; information generated from the computerized nutrient analysis of the component's formulation; data from the United States Department of Agriculture (USDA) and commercial databases for similar items and communications with the developers of the products. Using the formula generated from the computer analysis of the product, the calculated energy values were determined for each component using USDA values for energy (8).

Programs were written to generate the summarized data for each component of the MRE from the data in the database. In doing this, data were compiled for a newly produced component based on a random number of samples, representative of all manufacturers. To create the final nutrient profile for each component, several new fields were generated. Carbohydrate was determined by difference ( $\text{carbohydrate} = \text{weight} - [\text{water} + \text{protein} + \text{fat} + \text{ash}]$ ), and energy was determined using the calculated energy values. For the vitamins, a value for total vitamin A (vitamin A and carotene) was compiled and converted from International Units to Retinol Equivalents. From the data on the individual fatty acids, the total saturated, monounsaturated and polyunsaturated fatty acids were determined.

The nutrient data in this report reflect the compilation of data for the individual components being procured at the time and not subjected to storage. Therefore, a formulation, fortification or weight change would be reflected in the data. Since there was less variability in the MRE VIII - XV components made using a military specification that included a formulation, the earlier nutritional data were considered more reliable. The more recent versions of the MRE (XVI and later) include food components that were not required to be prepared according to a formulation specified by the military. Therefore, manufacturers of products made after 1995 could be using a different formulation to produce dissimilar components with the same name. Data representative of all manufacturers were combined to provide a generic value for these later versions of the MRE.

## DESCRIPTIVE DATA for MRE VIII - XIX

### COMPONENTS and MENUS

Appendix A presents the components available in the various versions of the MRE. The summary at the end of Appendix A suggests that as the MRE evolved and the number of menus increased, there was a tendency toward fewer components per menu. However, the decline in the average number of components per menu in the later MREs was due in large part to the substitution of new beverage items in place of three components (coffee, cream and sugar) in approximately half of the Accessory Packets in MRE XVII, XVIII and XIX. In fact, by excluding the components in the accessory packet from the count, the variety of MRE items has more than doubled over the years. Varieties within some food components (fruits, cakes, candies and beverages) and the recently added snacks have considerably increased the consumers' choices. However, there have been exceptions to this trend. For example, there were fewer occurrences of fruits in the later versions of the ration due to weight considerations. A serving of the newer thermostabilized fruits was approximately nine to ten times heavier than the freeze-dried fruits.

Appendices B - J provide menus for MRE VIII - XIX, and Appendix K presents more detailed information on the nutrient content of the individual meals in MRE XIX.

### WEIGHT

The data in Table 1 indicate the average weights of the MRE, without the packaging, for the different versions of the MRE over the past 12 years. While there have been some fluctuations, the weight has tended to increase since MRE VIII.

Table 1. Average Gram Weight of the MRE.

MRE Version	Weight+Std Dev
VIII & IX	473+47
X	460+50
XI & XII	480+51
XIII & XIV	466+59
XV	475+40
XVI	511+60
XVII	514+54
XVIII	491+71
XIX	495+68

### NUTRIENT CONTENT of MRE VIII - XIX

Analyses of Variance were run on the data for MRE VIII - XIX using SAS Statistical Software (5), with significant differences between means determined using

Table 2. Meal, Ready-to-Eat Nutrient Content.

		<b>MRE Version</b>															
		Meal, Ready-to-Eat VIII & IX (12 menus)															
		Meal, Ready-to-Eat X (12 menus)															
		Meal, Ready-to-Eat XI & XII (12 menus)															
		Meal, Ready-to-Eat XIII & XIV (12 menus)															
		Meal, Ready-to-Eat XV (12 menus)															
		Meal, Ready-to-Eat XVI (16 menus)															
		Meal, Ready-to-Eat XVII (20 menus)															
		Meal, Ready-to-Eat XVIII (24 menus)															
		Meal, Ready-to-Eat XIX (24 menus)															
<b>MRE</b>	<b>Water</b> <b>g</b>	<b>Energy</b> <b>kcal</b>	<b>Protein</b> <b>g</b>	<b>Fat</b> <b>g</b>	<b>Carb</b> <b>g</b>	<b>D Fiber</b> <b>g</b>	<b>Ash</b> <b>g</b>	<b>Ca</b> <b>mg</b>	<b>Fe</b> <b>mg</b>	<b>Mg</b> <b>mg</b>	<b>P</b> <b>mg</b>	<b>K</b> <b>mg</b>	<b>Na</b> <b>mg</b>	<b>Zn</b> <b>mg</b>	<b>Cu</b> <b>mg</b>	<b>Cl</b> <b>g</b>	
MRE VIII & IX	209.91	1228	43.51	47.49	162.97	7.07	8.13	314	7.21	142	711	1215	1771	5.62	0.907	3.8	
MRE X	210.27	1168 <sup>a</sup>	42.60	45.05	154.04	6.95	7.92	304	7.13	137	703	1152	1744	5.60	0.905	3.8	
MRE XI & XII	213.24	1241	43.18	47.46	167.00	7.14	8.13	322	7.52	142	718	1169	1788	5.72	0.953	3.9	
MRE XIII & XIV	214.39	1197	40.35	50.13	152.47 <sup>a</sup>	7.07	8.05	314	7.40	136	701	1186	1776	5.56	0.942	3.9	
MRE XV	217.53	1235	40.70	53.22	155.03	7.49	8.18	328	7.49	142	727	1205	1797	5.45	0.978 <sup>a</sup>	3.9	
MRE XVI	233.94	1299 <sup>b</sup>	38.22	50.73	179.50 <sup>b</sup>	7.54	8.04	304	7.31	133	673	1091	1838	5.21	0.956 <sup>a</sup>	4.1	
MRE XVII	245.67	1270 <sup>b</sup>	39.34	51.97	168.50	7.68	8.26	296	7.27	136	639	1038	1943	5.17	0.861	4.5	
MRE XVIII	232.82	1224	37.23	51.32	160.47	7.28	8.49	350	6.74	130	623	1043	2056	4.82	0.730 <sup>b</sup>	4.8	
MRE XIX	233.85	1241	38.13	52.39	161.68	7.66	8.72	372	6.80	137	653	1086	2075	4.89	0.758	4.8	
One-third NSOR *		1200	33.33	<53.33	146.67			267	6.00	133	267	625-1875	<1667-2333	5.00			
<b>MRE</b>	<b>Vit C</b> <b>mg</b>	<b>Thiamin</b> <b>mg</b>	<b>Ribo</b> <b>mg</b>	<b>Niacin</b> <b>mg</b>	<b>Vit B6</b> <b>mg</b>	<b>Folate</b> <b>mcg</b>	<b>Vit B12</b> <b>mcg</b>	<b>Vit A tot</b> <b>IU</b>	<b>Vit A tot</b> <b>RE</b>	<b>Carotene</b> <b>RE</b>	<b>Vit E</b> <b>mg</b>	<b>SFA</b> <b>g</b>	<b>MFA</b> <b>g</b>	<b>PFA</b> <b>g</b>	<b>Chol</b> <b>mg</b>		
MRE VIII & IX	161.5	2.376	1.033	12.864	2.62	60 <sup>a</sup>	1.48	4828	1284	82.13	5.9	16.47	20.99	6.76	126		
MRE X	146.5	2.367	0.999	12.475	2.64	58 <sup>a</sup>	1.49	4823	1283	82.04	5.7	15.31	20.17	6.41	124		
MRE XI & XII	144.5	2.374	1.032	12.513	2.65	59 <sup>a</sup>	1.51	4920	1294	91.30	5.8	16.91	20.77	6.52	125		
MRE XIII & XIV	133.0	2.408	1.009	12.070	2.63	57 <sup>a</sup>	1.42	4835	1284	83.37	5.0	18.42	21.92	6.42	128		
MRE XV	134.5	2.487	1.007	12.931	2.72	56 <sup>a</sup>	1.38	5138	1359	91.24	4.9	19.31	23.43	6.93	108		
MRE XVI	158.6	2.365	1.001	12.700	2.58	55 <sup>a</sup>	1.30	4785	1227	104.61	5.6	17.19	22.60	7.46	99		
MRE XVII	134.3	2.304	0.990	13.482	2.55	59 <sup>a</sup>	1.29	4425	1145	91.65	5.8	16.33	23.12	8.68	101		
MRE XVIII	91.4	2.362	1.022	12.917	2.53	62 <sup>a</sup>	1.12	4569	1189	91.29	5.8	15.85	22.48	8.94	92		
MRE XIX	93.2	2.386	1.017	13.337	2.56	128 <sup>b</sup>	1.13	4677	1220	92.23	5.9	15.91	23.23	9.31	91		
One-third NSOR	20.0	0.600	0.733	8.000 NE	0.73	133	1.00		333		3.3						

\* NSOR = Nutritional Standard for Operational Rations  
For each nutrient, means with different letters are significantly different at  $p \leq 0.05$   
For each nutrient, means with no letters are not significantly different

Tukey's Studentized Range (HSD) Test, and reported in Table 2. The menu totals were averaged to provide the means for each version of the ration. See Appendix K for the MRE XIX data used for presentation in Table 2. The data for each nutrient were compared over the nine versions of the MRE. Because the menus were the same for MRE VIII and IX, as well as for XI and XII, and XIII and XIV, the data for these ration pairs were combined. One third of the daily NSOR is presented throughout this report as a basis for comparing the average meal to the requirements established for the military services in the Nutrition Allowances, Standards and Education, AR 40-25 (1).

## PROXIMATES

### Water

Although not statistically significant, it appears that there has been a tendency for the water (moisture) content of the MRE to increase over the years (Table 2). The addition of rice dishes in MRE XVI, and buttered noodles in MRE XVIII, contributed to the tendency for moisture content to rise. In addition, the fruits were converted from a freeze-dried product to thermostabilized fruits starting in MRE XIII and XIV, with the largest number of occurrences of thermostabilized fruits in MRE XVI and XVII (Appendix A). The water content of these components also affects the final weight of the ration. In correlating weight with the proximate nutrients that make up the weight of any component (water, protein, carbohydrate, fat and ash), water and weight had the highest correlation.

The moisture contained in ration components contributed to the warfighters' fluid intake, as does consumption of the MRE beverages. Many of the beverage components require rehydration, as shown in Table 3. The 2 fluid ounces of water sometimes used to reconstitute the freeze-dried fruits found in MRE VIII - XV is not included in Table 2 or 3. One reason for the decreased requirement for water in the later MREs is the substitution of one beverage that could be consumed either hot or cold for two beverages, one hot and one cold, in earlier versions of the ration.

Table 3. Water Requirements (fluid ounces) to Reconstitute Beverages.

Requirements	MRE VIII&IX	MRE X	MRE XI&XII	MRE XIII&XIV	MRE XV	MRE XVI	MRE XVII	MRE XVIII	MRE XIX
Average water req/menu	24	22	22	20	19	22	17	16	16
Range of water req/menu	20 - 26	18 - 24	18 - 24	18 - 24	18 - 20	18 - 26	8 - 24	8 - 26	8 - 26

### Energy

MRE X contained significantly less energy compared to MRE XVI and XVII, which contained the highest number of kilocalories. These three MREs were also the lightest (X) and heaviest (XVI and XVII) in weight. The broadest range of energy per menu within any given version of the MREs was in MRE XVI, which contained the two

menus in the different versions of the MREs in this report with the least and most energy (approximately 1084 kcal in Menu 11 and approximately 1555 kcal in Menu 5). The energy values will vary in proportion to the macronutrients, since energy is calculated from the protein, fat and carbohydrate content. The percentages (Table 4) of calories from protein, fat and carbohydrate have fluctuated slightly over the years, with the percentage of calories from protein showing the most consistent pattern of change.

Table 4. Percentage of Calories from Protein, Fat and Carbohydrate.

MRE version	Protein	Fat	Carbohydrate
VIII & IX	14	34	52
X	14	34	52
XI & XII	14	34	53
XIII & XIV	13	37	50
XV	13	38	49
XVI	12	34	54
XVII	12	36	52
XVIII	12	37	51
XIX	12	37	51

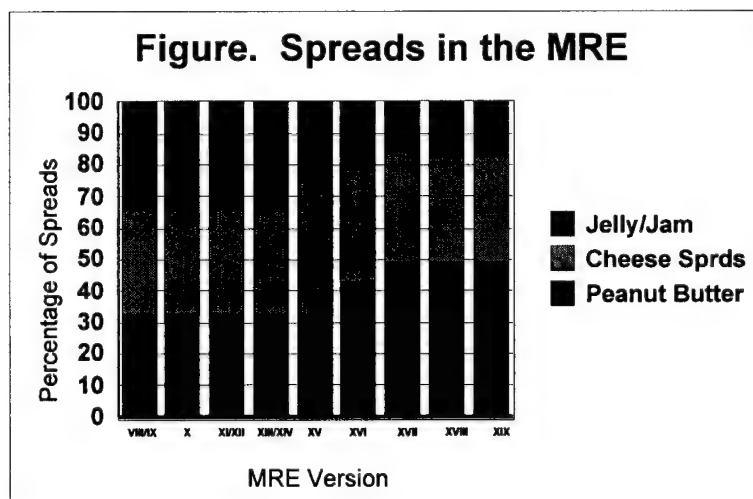
### **Protein**

Table 2 indicates that the amount of protein in the MRE has tended to decline over the years. The same pattern is apparent when the protein content of the ration is expressed as a percentage of calories (Table 4). This tendency was mainly due to the lower levels of protein in the entrees, especially the vegetarian entrees in the later versions of the ration. For MRE VIII - XV, the main contributors of protein per serving were the entrees. For MRE XVI - XVIII, the top contributors of protein on a per serving basis were the non-vegetarian entrees, followed by peanut butter and then the vegetarian entrees. For MRE XIX (24 menus), there were 20 non-vegetarian entrees, which provided the most protein on a per serving basis, followed by nut raisin mix and peanut butter, which contributed more protein per serving than the four vegetarian entrees. On average, the four vegetarian meals in MRE XIX provided 29.78 grams of protein, which falls below one-third of the NSOR (33.33 grams). Yet, the average protein for the MRE (including MRE XIX) exceeded the nutritional standard.

### **Fat, Saturated Fatty Acids and Cholesterol**

Of the groups of components described in Appendix A, the spreads contributed more fat on a per serving basis to the average ration than the entrees or any other group of components. Because there are more fat-containing spreads than fat-free spreads being offered as components in later versions of the MRE, the fat content of the MRE has shown a tendency to rise. Of the spreads offered in the menus (see Figure), the percentage of fat-containing spreads (peanut butter and cheese spreads) has increased from 67% of the spreads in MRE VIII - XIV to 75% - 85% for MRE XV -

XIX. Even with the addition of jam in MRE XVII, the percentage of jelly and jam in the spreads has decreased (see Figure). The average fat in the MRE versions considered in this report has met the nutritional standard.



Of all the components in MRE VIII - XII, cheese spread contributed the most saturated fat per serving. In MRE XIII - XIX, frankfurters and the cheese spreads contributed the most saturated fat on a per serving basis. As seen in Table 2, the cholesterol level appears to be higher in the earlier versions of the MRE. Before 1995, the Omelet with Ham component primarily affected the higher cholesterol content of the ration but was eliminated after MRE XIV. Since the 1985 NSOR did not have a standard for saturated fatty acids (SFA) or cholesterol, the MRE was not designed to meet any requirement.

### **Carbohydrate and Dietary Fiber**

There was a significant difference found between the carbohydrate content of MRE XIII/XIV and XVI. The difference in carbohydrate content appears to be attributable to changes in the beverage components. There were more beverages offered in MRE XVI (1.9 per meal) versus MRE XIII/XIV (1.6 per meal). In addition, 50% of the beverages in MRE XIII/XIV were sweetened with aspartame rather than sugar. The aspartame-sweetened beverages, which only appeared in MRE XIII - XV, are no longer part of the ration. Despite these variations, the MRE consistently met the NSOR for carbohydrate.

Although changes did not achieve statistical significance, the data in Table 2 suggest a slight tendency for dietary fiber to increase over the years. The increasing occurrences of peanut butter in the later MREs contributed to the tendency for the dietary fiber content to increase. Since there is no military standard for dietary fiber in the rations, the rations were not designed to provide a specified amount.

## **MINERALS**

### **Calcium**

The calcium content of the MRE has been fairly consistent since 1988, with a slight tendency towards higher levels in MRE XVIII and XIX. The fortified crackers have had a large impact on the calcium content of the MRE because they were found in so many menus, but plain crackers with unsalted tops were not the largest contributors of calcium on a per serving basis. For MRE VIII - XVII, cheese spread was the largest contributor of calcium on a per serving basis. In MRE XVIII and XIX, the vegetable crackers, made according to the military specification, were contributing the most calcium on a per serving basis. In MRE XIX, cheese spread, wheat snack bread and the chocolate sport bar provided more than 100 mg calcium per serving.

### **Iron**

While the data presented in Table 2 show that the iron content has met the NSOR, there seems to be a tendency for the iron content to be decreasing, possibly attributable to declining levels of iron in the individual entrees. For example, the iron content per serving of the entrees in MRE VIII ranged from 1.34 mg to 4.35 mg and for entrees in MRE XIX, from 0.42 mg to 3.67 mg.

### **Magnesium, Phosphorus and Potassium**

For all versions of the MRE considered except MRE XVIII, the average amount of magnesium per meal met the NSOR. The MRE menus provide phosphorus well in excess of the NSOR. The potassium in the MREs was within the range stated in the NSOR.

### **Sodium**

The data in Table 2 indicate that the sodium in the MREs was within the range stated in the NSOR, with MRE XVIII and XIX slightly exceeding 2000 mg in the average meal. The range for the MRE meals varied from a low of less than 1000 mg (Menu 10 in MRE XIV) to over 3000 mg (Menu 4 in MRE XVIII and XIX). The calculations of the sodium per meal DID NOT include the salt packet that would provide 1550 mg of sodium per 4-gram packet.

### **Zinc**

While the differences in zinc content of the MRE have not achieved statistical significance, zinc values have tended to decline and are below the nutritional standard for the operational ration in MRE XVIII and XIX. Zinc is correlated with protein in most dietary assessments and, as mentioned above, there appears to have been a tendency toward less protein in the ration. After MRE XVII, the elimination of the oatmeal cookie



bar, which was fortified with a mineral premix containing zinc, has also contributed to the lesser amounts of zinc. While the fruit bar, which appeared in MRE XVIII and XIX, was fortified with zinc, this item contained only about 70% as much zinc as the oatmeal cookie bar. In addition, the fruit bar is a commercial item, and since there is no requirement (in the military document) that it contain added zinc, its fortification is at the discretion of the manufacturer.

## **Copper**

The statistical analysis of the MRE showed that the copper content of MRE XVIII was significantly lower than the copper content of MRE XV and XVI. Again, the elimination of the oatmeal cookie bar, which was fortified with a mineral premix containing copper, contributed to this decrease. When ranked with all of the components for MRE VIII through MRE XVII, the oatmeal cookie bar consistently provided the most copper on a per serving basis. Copper is not one of the required nutrients in the NSOR.

## **VITAMINS**

### **Vitamin C**

Although not statistically significant, Table 2 suggests a tendency for a decline in the amount of vitamin C in the MREs over the years. MRE VIII and IX appear to have slightly more vitamin C than the other MRE versions, since the instant coffee was fortified with vitamin C in the earliest MREs. Applesauce, which has added ascorbic acid, was in only one menu in MRE XVIII and XIX (4% of 24 menus), whereas in MRE VIII - XVII, applesauce was in 15% - 19% of the menus. In MRE XVIII and XIX, spiced apples, which do not have ascorbic acid added, replaced applesauce. There are also fewer beverages fortified with vitamin C available in later versions of the MRE (XVI - XIX). All of these factors contributed to the tendency toward lower amounts of vitamin C available in the later versions of the ration.

### **Thiamin, Riboflavin, Niacin and Vitamin B<sub>6</sub>**

As Table 2 shows, each of the MRE versions contained amounts of four B vitamins (thiamin, riboflavin, niacin, vitamin B<sub>6</sub>) that exceeded the NSOR. Part of the reason for this is the fortification (thiamin, riboflavin, niacin, vitamin B<sub>6</sub> and calcium) of the crackers in the MRE. In addition to the fortification required according to the military specification, the Food and Drug Administration (FDA) enrichment of grain products mandated the addition of thiamin, riboflavin and niacin. Cocoa, cheese spread, peanut butter, chocolate-covered cookies and chocolate-covered brownies were all fortified with vitamin B<sub>6</sub>. In Table 2, niacin equivalents used for the NSOR include the niacin available from the amino acid, tryptophan. Calculating niacin equivalents (NE) for the MREs would result in a range of 18.794 NE (for MRE XIV) to 20.116 NE (for MRE VIII), well in excess of one-third of the NSOR.



## **Folate**

The folate content of the earlier MREs (VIII - XVIII) was consistently less than half of the NSOR. For MRE XIX, the folate data were calculated assuming that the manufacturers were enriching selected grain products with folic acid according to the 1998 FDA guidelines, and complying with the military documents, which require enrichment. Therefore, the statistical analysis shows a significant increase in the average folate value for MRE XIX when compared to the other versions of the MRE considered (Table 2). While the amount of folate available in MRE XIX was significantly higher than previous versions of the MRE, levels still remained slightly below the NSOR.

## **Vitamin B<sub>12</sub>**

Vitamin B<sub>12</sub> is usually found to be associated with protein intake derived from animal sources. Therefore, it was not surprising that the amount of this vitamin tended to decline, especially with the introduction of the vegetarian entrees. Vitamin B<sub>12</sub> was nonexistent or found in very small amounts (<0.15 mcg) in the four vegetarian meals in MRE XIX (Menus 11, 12, 13, 14). Therefore, any consumer who chooses to eat only the vegetarian meals would not be receiving adequate amounts of vitamin B<sub>12</sub> to meet the military standard. Yet, unrestricted consumption of all components in each version of the MRE (including MRE XIX) would provide sufficient vitamin B<sub>12</sub> to meet the NSOR.

## **Vitamin A and Vitamin E**

The MREs met the NSOR for vitamin A because the vitamin was included as part of the fortification in cocoa, cheese spreads, peanut butter, chocolate-covered cookies and chocolate-covered brownies. Total vitamin A was derived from combining vitamin A and carotene. Vitamin E content of the MRE has been fairly consistent over the years and exceeded the requirement of the NSOR.

## **OTHER NUTRIENTS**

Ash, chloride as NaCl, monounsaturated fatty acid (MFA) and polyunsaturated fatty acid (PFA) content of the rations presented in Table 2 will not be discussed. The ash content is presented for information only since these values are used to calculate carbohydrate by difference. Chloride generally parallels the sodium content and is reported because the food technologists use this as an indicator of the salt content of the products. The fatty acids (MFA and PFA) are presented because, along with the SFA, they make up the total fatty acids.

## **DISCUSSION**

The composition of the MRE underwent many changes between 1988 and 1999. The numbers of menus and components increased, and there were more commercial

items added to the ration. Yet, the changes did not necessarily mean a pattern of improvement in the nutritional content of the ration. The military specifications for ration components have been replaced, in many cases, by documents leading to more variability in the components and, subsequently, in the nutrient content within the ration. Therefore, the ration designers cannot rely on the manufacturers to consistently provide a product with the same ingredients, fortification or weight in successive years. In January 1998, the FDA law that added folic acid to the required enrichment (thiamin, riboflavin, niacin and iron) for selected grains affected the military components and increased the overall folate content of the ration. In response to surveys of consumers' food preferences, the MRE now contains vegetarian meals, more fat-containing spreads and more commercial items. Yet, looking at MRE XIX, the four vegetarian meals on average contained less protein and vitamin B<sub>12</sub> than the non-vegetarian meals in that version of the ration. The increase in fat-containing spreads (cheese spreads and peanut butter) in the ration has resulted in a pattern of higher fat content in the MRE. While the fat-containing spreads are fortified (thiamin, vitamins A, B<sub>6</sub>, and C), the total amounts of these four vitamins in MRE XIX menus are more than three times the NSOR. The use of aspartame to sweeten beverages in MRE XIII - XV resulted in a lower carbohydrate level, and the aspartame-sweetened beverages have been eliminated from later versions of the ration. Elimination of the oatmeal cookie bar, which contained a mineral premix, has contributed to the tendency toward lower levels of zinc, copper, magnesium and iron in the MRE. While the oatmeal cookie bar was replaced with a commercial item, popular with the warfighter, the nutrient content of this item may vary from one year to the next.

Fortification is the most common means employed to improve the nutrient content of the MRE. However, the need for fortification should be considered on a case-by-case basis in order to best utilize resources. Using MRE XIX as an example, the meals would meet the requirements for the B vitamins (thiamin, riboflavin, niacin and vitamin B<sub>6</sub>) in AR 40-25 without the fortification currently required according to the military documents. Yet, vitamins A, C and calcium must be added in order to meet the standard in AR 40-25. Thus, there are some nutrients that are added to excess, some nutrients added in order to meet the NSOR, while others that do not meet the standard are not added. Zinc (in MRE XVIII and XIX) and folate, which were not part of the fortification, fell below the standard and should be added. There are other nutrients, such as magnesium, which only slightly exceed the NSOR in the menus as they were planned and may not meet the military standard if all components of every meal in the ration were not eaten. Since the distribution of nutrients among the components influences nutritional adequacy, nutrients, such as magnesium, should be considered as an addition to the fortification to insure compliance with the military standard.

The nutrient data in the Natick/USARIEM Nutrient Database for Military Operational Rations, Third Edition (7), are generally considered more accurate than the pre-1993 database, because more laboratory analyses on additional samples were available. Furthermore, the new database format provided a means to more easily review the data for accuracy and consistency. Moreover, recent USDA data were used

for the calculations in the reported database. Therefore, readers of reports on the MRE should be aware of what nutrient database was used for analysis of the data. This will be a continuing concern, as the new nutrient data, based on the computer analyses generated by the MRE contractors, becomes the standard for MRE nutrient data, beginning with MRE XX. Nutrient data will seldom be a perfect match for the components being used for a study because of the variability in ingredients, formulations, production lots and storage of the products. Even if all components were analyzed, there may be problems when there are only limited laboratory analyses available and extensive analyses are generally cost prohibitive.

To use a 1995 technical report as an example, the "Nutrient Intakes and Nutritional Status of Soldiers Consuming the Meal, Ready-to-Eat (MRE XII) During a 30-Day Field Training Exercise" (6) was analyzed using the pre-1993 database. While the intake data were not reanalyzed, a comparison of the average MRE XII meal calculated from data in the older database (used in the 1995 report) was made with the average per meal data from the Natick/USARIEM Nutrient Database for Military Operational Rations presented in this paper. A t-test (5) revealed statistically significant differences ( $p \leq 0.05$ ) for seven nutrients. Dietary fiber, copper and the fatty acids (saturated, monounsaturated and polyunsaturated) were not compared because they were not reported in the pre-1993 database. As presented in Table 5, energy, protein and calcium were significantly less when calculated using the newer version of the database, and the amounts of the following nutrients significantly increased in the latest analysis of MRE XII menus: iron, zinc, vitamins B<sub>6</sub> and B<sub>12</sub>. These data represent the average meal and must be multiplied by 3 to determine the average daily amount available. Thus, when looking at energy, for example, there could be as much as a 320 kcal difference in the daily meals as they were planned, depending on which database was used for the analysis.

Table 5. Comparison of Nutrients from MRE XI - XII Using Two Databases.

Database	Energy (kcal)	Protein (g)	Ca (mg)	Fe (mg)	Zn (mg)	Vit B <sub>6</sub> (mg)	Vit B <sub>12</sub> (mcg)
Pre-1993	1348	49.17	513	6.08	3.35	1.91	0.88
Natick/USARIEM	1241	43.18	322	7.52	5.72	2.65	1.51

## RECOMMENDATIONS

Review of the nutrient content of MRE VIII - XIX suggests that improvements could be made. The amounts of magnesium, zinc and folate in MRE XIX were very close to the NSOR and should be increased in future versions of the MRE. In order to reverse the pattern of increasing fat (which is approaching the NSOR), a reduction in the package weight of the fat-containing spreads or a decrease in the number of these spreads in the MRE should be considered.

In addition to the nutrients which should continue to be added (calcium, vitamin A and C) to meet the NSOR, magnesium, zinc and folate should be considered as

nutrients to be added via fortification. In changing fortification of MRE components, new documents should specify an upper as well as a lower tolerable limit for each nutrient added, since several nutrients (thiamin, vitamins A, B<sub>6</sub> and C) contribute more than three times the standard set in AR 40-25.

Finally, when evaluating research reports and subsequently establishing ration policy, the reliability and accuracy of the nutrient database used for analyzing data must be considered. Changes in trends over time may be attributable to the nutrient database used rather than actual changes in the composition or consumption of the ration.

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# **APPENDIX A** **Components in MRE VIII - XIX**

Entree	VIII&IX (12 menus)	X (12 menus)	XI&XII (12 menus)	XIII&XIV (12 menus)	XV (12 menus)	XVI (16 menus)	XVII (20 menus)	XVIII (24 menus)	XIX (24 menus)
Prk Rice BBQ	1	1	1	1	1	1	1		
Crn Beef Hsh	1	1	1	1					
Chicken Stw	1	1	1	1	1	1	1	1	1
Omlet w/Ham	1	1	1	1					
Spag Mt Sce	1	1	1	1	1	1	1	1	1
Chick ala king	1	1	1						
Beef Stew	1	1	1	1	1	1	1	1	1
Ham Slice	1	1	1	1	1	2	1	1	1
Mtballs in Sce	1	1	1						
Tuna Noodle	1	1	1	1	1	1	1		
Chicken Rice	1	1	1	1	1	1	1	1	1
Esc Pot Ham	1	1	1	1	1	1			
Franks				1	1	1	1	1	1
Pk Chow Mein				1	1	1	1	1	1
Chili Mac					1	1	1	1	1
Grilled Chicken					1	1	1	1	1
BeefSteak						1	1	1	1
Pasta w/veg (v)						1	1	1	1
Cheese Tortellini (v)						1	1	1	1
Pork Chp Noodles							1	1	1
Chicken Noodles							1	1	1
Chicken Cavatelli							1	1	1
Beef Ravioli							1	1	1
Turkey Potatoes							1	1	1
Beef Mshrm							1	1	1
Beef Teriyaki								1	1
Chicken Salsa								1	1
Bn&Rce Burrito (v)								1	1
Pasta Alfredo (v)								1	1
Chicken Thai Sce								1	1
Meatloaf								1	1

(v) Vegetarian entree

## **Fruit**

Fruit dry 3 - 4 varieties	5	5	4	3	2				
Applesauce	2	2	2	2	2	3	3	1	1
Fruit wet 3 - 4 varieties				1	2	5	7	4	4
Spiced Apple								2	2

## **Starch**

Cracker	12	12	12	12	12	16	20	12	11
Potato au Grat	2	2	2	2	2				
Chw Mein Nd				1	1	1	1	1	1
Mexican Rice						2	2	2	3
White Rice						2	3	4	3
Vegetable Cracker								12	11
Noodles in Sce								2	2
Wht Snack Bread									2

## Components in MRE VIII - XIX (continued)

	VIII&IX	X	XI&XII	XIII&XIV	XV	XVI	XVII	XVIII	XIX
Spread	(12 menus)	(12 menus)	(12 menus)	(12 menus)	(12 menus)	(16 menus)	(20 menus)	(24 menus)	(24 menus)
Cheese Sprd	4	4	4	4	5	1	4	5	4
Peanut Butter	4	4	4	4	4	7	10	12	12
Jelly	4	4	4	4	3	3	2	2	2
Jalapeno Chse Spr						5	3	3	4
Jam							1	2	2

### Dessert

Cake, nut 3 varieties	3	3	3						
Oat cookie bar	2	2	2	2	2	2	1		
Cookie chcv	2	2	2	2	2	2	2	2	1
Brownie chcv	2	2	2	2	2				
Pound cake 5 - 6 varieties				3	4	5	7	7	7
Fudge Brownie						2	2	2	2
Fig bar							3	2	1
Shrtbrd Cookies								1	1

### Snack

Potato Stck				1	1	1	1	1	1
Peanuts					1		2	1	1
Pretzels							1	1	1
Granola bar						1	1	2	3
Beef Jerky							1	1	1
Corn Chips							1		
Frt-filled bar								2	2
Choc Sport bar								1	1
Toaster Pastry								1	1
Cracker w/pb									2
Nut raisin Mix									1

### Candy

Candy meal bag*	4		3	6	6	7	7	4	4
Peanut bar							1	3	2
Hard Candy***									2

### Beverage

Bev base sug 3 - 4 varieties	12	12	12	6	5	16	11	10	10
Cocoa	7	7	7	7	7	7	7	9	10
Bev base asp 3 varieties				6	7				

### Hot Sauce

Tabasco			12						
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## Components in MRE VIII - XIX (continued)

Acc Pkt	VIII&IX (12 menus)	X (12 menus)	XI&XII (12 menus)	XIII&XIV (12 menus)	XV (12 menus)	XVI (16 menus)	XVII (20 menus)	XVIII (24 menus)	XIX (24 menus)
Coffee	12	12	12	12	12	9	10	9	11
Cream	12	12	12	12	12	16	10	11	13
Sugar	12	12	12	12	12	16	10	11	13
Gum	12	12	12	12	12	16	20	24	24
Tabasco	4	4		12	12	16	20	24	24
Candy**		4	4	2	2	2	2	4	2
Lemon tea w/sugar						7	10	13	11
Apple cider							3	7	5
Tea bag								2	2
Count	33	31	30	36	37	41	54	64	68
Total	129	129	139	142	144	186	209	243	247
Components/menu	11	11	12	12	12	12	10	10	10

### VIII&IX

\* M&Ms plain, vanilla caramels or Charms in meal bag

### X

\*\* M&Ms plain, Tootsie Roll, vanilla caramels or Charms in Acc Pkt C

### XI&XII

\* Heat stable chocolate bar, M&Ms plain or Charms in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

### XIII&XIV

\* Heat stable chocolate bar, M&Ms plain or Charms in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

### XV

\* M&Ms plain or Charms in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

### XVI

\* M&Ms plain or Charms in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

### XVII

\* M&Ms plain, Charms, Skittles or Jolly Rancher candy in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

### XVIII

\* M&Ms plain, Charms, Skittles or Jolly Rancher candy in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

### XIX

\* M&Ms plain or Skittles candy in meal bag

\*\* Tootsie Roll or vanilla caramels in Acc Pkt B

\*\*\* Charms or Jolly Rancher candy in meal bag



# **APPENDIX B** **Menus for Meal, Ready-to-Eat VIII and IX**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12
Prk Rice BBQ	Cm Beef Hsh	Chicken Stw	Omlet w/Ham	Spag Mt Sce	Chick ala king	Beef Stew	Ham Slice	Mtballs in Sce	Tuna Noodle	Chicken Rice	Esc Pot Ham
		Potato au Grat					Potato au Grat				
Apple sauce	Fruit dry	Fruit dry			Fruit dry			Fruit dry		Fruit dry	Apple sauce
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Jelly	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Peanut Butter	Peanut Butter	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Jelly
	Oat cookie bar		Oat cookie bar	Maple nut cake		Cherry nut cake	Brownie chcv	Cookie chcv	Choc nut cake	Cookie chcv	Brownie chcv
Candy*		Candy			Candy					Candy	
Cocoa	Cocoa	Cocoa	Cocoa		Cocoa		Cocoa				Cocoa
Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar
Acc Pkt B**/Acc Pkt A**	Acc Pkt A**	Acc Pkt B	Acc Pkt A	Acc Pkt B	Acc Pkt A	Acc Pkt B	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A

\* M&Ms plain, vanilla caramels, or Charms

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum

Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco

# **APPENDIX C** **Menus for Meal, Ready-to-Eat X**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12
Prk Rice BBQ	Crn Beef Hsh	Chicken Stw	Omlet w/Ham	Spag Mt Sce	Chick ala king	Beef Stew	Ham Slice	Mtballs in Sce	Tuna Noodle	Chicken Rice	Esc Pot Ham
Apple sauce	Fruit dry	Fruit dry	Potato au Grat		Fruit dry		Potato au Grat	Fruit dry		Fruit dry	Apple sauce
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Jelly	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Peanut Butter	Peanut Butter	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Jelly
	Oat cookie bar		Oat cookie bar	Maple nut cake		Cherry nut cake	Brownie chcv	Cookie chcv	Choc nut cake	Cookie chcv	Brownie chcv
Cocoa	Cocoa	Cocoa	Cocoa		Cocoa		Cocoa				Cocoa
Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar
Acc Pkt C*	Acc Pkt B*	Acc Pkt C	Acc Pkt B	Acc Pkt B	Acc Pkt C	Acc Pkt A*	Acc Pkt A	Acc Pkt A	Acc Pkt B	Acc Pkt C	Acc Pkt A

\* Acc Pkt A: Coffee, cream, sugar, chewing gum

Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco

Acc Pkt C: Coffee, cream, sugar, chewing gum, candy (M&Ms plain, Tootsie Roll, vanilla caramels or Charms)

# **APPENDIX D** **Menus for Meal, Ready-to-Eat XI and XII**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12
Prk Rice BBQ	Crm Beef Hsh	Chicken Stw	Omlet w/Ham	Spag Mt Sce	Chick ala king	Beef Stew	Ham Slice	Mtballs in Sce	Tuna Noodle	Chicken Rice	Esc Pot Ham
Apple sauce	Fruit dry	Fruit dry	Potato au Grat		Fruit dry		Potato au Grat	Fruit dry			Apple sauce
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Jelly	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Peanut Butter	Peanut Butter	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Jelly
	Oat cookie bar		Oat cookie bar	Maple nut cake		Cherry nut cake	Brownie chcv	Cookie chcv	Choc nut cake	Cookie chcv	Brownie chcv
Cocoa	Cocoa	Cocoa	Cocoa	Candy*	Candy					Candy	
					Cocoa		Cocoa				Cocoa
Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar
Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco	Tabasco
Acc Pkt B**	Acc Pkt B	Acc Pkt B	Acc Pkt B	Acc Pkt A**	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A

\* Heat stable chocolate bar, M&Ms plain or Charms

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum

Acc Pkt B: Coffee, cream, sugar, chewing gum, candy (Tootsie Roll or vanilla caramels)

# **APPENDIX E** **Menus for Meal, Ready-to-Eat XIII and XIV**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12
Prk Rice BBQ	Crm Beef Hsh	Chicken Stw	Omlet w/Ham	Spag Mt Sce	Franks	Beef Stew	Ham Slice	Pk Chow Mein	Tuna Noodle	Chicken Rice	Esc Pot Ham
			Potato au Grat				Potato au Grat	Chw Mein Nd			
Apple sauce	Fruit dry	Fruit wet			Fruit dry			Fruit dry			Apple sauce
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Jelly	Jelly	Peanut Butter	Jelly	Cheese Sprd	Peanut Butter	Peanut Butter	Cheese Sprd	Peanut Butter	Jelly	Cheese Sprd	Cheese Sprd
	Oat cookie bar		Oat cookie bar	Pound cake		Pound cake	Brownie chcv	Cookie chcv	Pound cake	Cookie chcv	Brownie chcv
				Potato Stck							
		Candy*	Candy	Candy	Candy				Candy	Candy	
Cocoa	Cocoa		Cocoa	Cocoa	Cocoa		Cocoa				Cocoa
Bev base asp	Bev base asp	Bev base sugar	Bev base asp	Bev base asp	Bev base asp	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base asp
Acc Pkt B**	Acc Pkt B	Acc Pkt A**	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A

\* Heat stable chocolate bar, M&Ms plain or Charms

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum, Tabasco

Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco, candy (Tootsie Roll or vanilla caramels)

# **APPENDIX F** **Menus for Meal, Ready-to-Eat XV**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12
Prk Rice BBQ	Chili Mac	Chicken Stw	Grilled Chicken	Spag Mt Sce	Franks	Beef Stew	Ham Slice	Pk Chow Mein	Tuna Noodle	Chicken Rice	Esc Pot Ham
			Potato au Grat				Potato au Grat	Chw Mein Nd			
Apple sauce	Fruit dry	Fruit wet			Fruit wet				Fruit dry		Apple sauce
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Peanut Butter	Jelly	Jelly	Peanut Butter	Jelly	Peanut Butter	Cheese Sprd	Cheese Sprd	Peanut Butter	Cheese Sprd	Cheese Sprd	Cheese Sprd
	Oat cookie bar	Pound cake	Pound cake	Oat cookie bar		Cookie chcv	Pound cake	Cookie chcv	Pound cake	Brownie chcv	Brownie chcv
Peanuts					Potato Stick						
				Candy*	Candy	Candy		Candy	Candy	Candy	
				Cocoa	Cocoa	Cocoa	Cocoa				Cocoa
Bev base sugar	Bev base sugar	Bev base asp	Bev base asp	Bev base asp	Bev base asp	Bev base asp	Bev base asp	Bev base sugar	Bev base sugar	Bev base sugar	Bev base asp
Acc Pkt A**/Acc Pkt B**	Acc Pkt B**	Acc Pkt A	Acc Pkt B	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A

\* M&Ms plain or Charms

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum, Tabasco

Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco, candy (Tootsie Roll or vanilla caramels)

# **APPENDIX G** **Menus for Meal, Ready-to-Eat XVI**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12	Menu 13	Menu 14	Menu 15	Menu 16
Beef-Steak	Tuna Noodle	Chicken Stw	Ham Slice	Spag Mt See	Franks	Beef Stew	Chicken Rice	Pk Chow Mein	Chili Mac	Pasta w/veg	Cheese Tortellini	Prk Rice BBQ	Ham Slice	Grilled Chicken	Esc Pot Ham
Mexican Rice			White Rice					Chw Mein Nd					White Rice	Mexican Rice	
	Fruit wet	Fruit wet			Fruit wet				Fruit wet	Apple sauce	Fruit wet	Apple sauce			Apple sauce
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Peanut Butter	Jalapeno Chse Spr	Jelly	Jalapeno Chse Spr	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Jalapeno Chse Spr	Peanut Butter	Jelly	Peanut Butter	Peanut Butter	Peanut Butter	Cheese Sprd	Jelly	Jalapeno Chse Spr
	Pound cake	Pound cake	Pound cake	Oat cookie bar		Cookie chcv	Fudge Brownie	Cookie chcv	Oat cookie bar				Pound cake	Pound cake	Fudge Brownie
					Potato Stick						Granola Bar				
				Candy*	Candy	Candy	Candy	Candy		Candy			Candy		
				Cocoa		Cocoa			Cocoa					Cocoa	Cocoa
Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar	Bev base sugar
Acc Pkt B**	Acc Pkt A**	Acc Pkt C**	Acc Pkt C	Acc Pkt C	Acc Pkt C	Acc Pkt C	Acc Pkt A	Acc Pkt A	Acc Pkt B	Acc Pkt C	Acc Pkt A	Acc Pkt C	Acc Pkt A	Acc Pkt A	Acc Pkt A

\* M&Ms plain or Charms

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum, Tabasco  
 Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco, candy (Tootsie Roll or vanilla caramels)  
 Acc Pkt C: Lemon tea w/sugar, cream, sugar, chewing gum, Tabasco

# **APPENDIX H** **Menus for Meal, Ready-to-Eat XVII**

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12	Menu 13	Menu 14	Menu 15	Menu 16	Menu 17	Menu 18	Menu 19	Menu 20
Beef- Steak	Pork Chp. Noodles	Chicken Stw	Ham Slice	Chicken Noodles	Franks	Pk Chow Mein	Chicken Rice	Beef Stew	Chili Mac	Pasta w/veg	Cheese Tortellini	Chk Rice BBQ	Chicken Cavatelli	Grilled Chicken	Tuna Noodle	Beef Ravioli	Turkey Potatoes	Beef Mushrm	Spag Mt Scc
Mexican Rice			White Rice			Chw Mein Nd							White Rice	Mexican Rice				White Rice	
	Apple sauce	Fruit		Fruit	Fruit						Apple sauce	Apple sauce			Fruit				
Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker	Cracker
Peanut Butter	Cheese Sprd	Jelly	Cheese Sprd	Peanut Butter	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Jalapeno Chse Spr	Jam	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Cheese Sprd	Jelly	Peanut Butter	Cheese Sprd	Peanut Butter	Peanut Butter	Peanut Butter
	Pound cake	Pound cake	Pound cake	Fig Bar		Ch Cov Cookies	Fudge Brownie	Ch Cov Cookies	Oat cooki bar	Fig Bar	Fig Bar		Pound cake	Pound cake	Pound cake	Fudge Brownie	Pound cake		Fig Bar
Peanuts					Potato Stck					Pretzels	Granola bar	Peanuts				Beef Jerky		Corn Chips	
					Candy*	Candy	Candy	Candy		Peanut bar					Candy		Candy		Candy
								Cocoa	Cocoa					Cocoa					Cocoa
Bev Base, w/sugar	Bev Base, sugar				Bev Base, sugar	Bev Base, sugar	Bev Base, sugar					Bev Base, sugar	Bev Base, sugar	Bev Base, sugar	Bev Base, sugar		Bev Base, sugar	Bev Base, sugar	
Acc Pkt B**	Acc Pkt A**	Acc Pkt C**	Acc Pkt C	Acc Pkt C	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt C	Acc Pkt D**	Acc Pkt D	Acc Pkt D	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt C	Acc Pkt C	Acc Pkt B	Acc Pkt C

\* M&Ms plain, Charms, Skittles or Jolly Rancher candy

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum, Tabasco

Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco, candy (Tootsie Roll or vanilla caramels)

Acc Pkt C: Lemon tea w/sugar, chewing gum, Tabasco

Acc Pkt D: Lemon tea w/sugar, apple cider, chewing gum, Tabasco

# APPENDIX I Menus for Meal, Ready-to-Eat XVIII

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12	Menu 13	Menu 14	Menu 15	Menu 16	Menu 17	Menu 18	Menu 19	Menu 20	Menu 21	Menu 22	Menu 23	Menu 24
Beef- Steak	Pork Chop Noodles	Beef Toriaki	Ham Slice	Grilled Chicken	Chicken Noodles	Chicken Salsa	Chicken Rice	Beef Stew	Chili Mac	Pasta w/veg	Burrito Burrito	Cheese Tortellini	Pasta Alfredo	Chicken Thai	Chicken Rice	Beef Ravioli	Turkey Potatoes	Beef Mushrm	Spag Mt Sce	Chicken Stw	Chicken Pk Chow	Chicken Cavatelli	Meatloaf
Mexican Rice		White Rice	Noodles in Sce	Mexican Rice										White Rice				White Rice		Chw Mein Nd	White Rice	Noodles in Sce	
	Fruit (Apple)				Fruit					Fruit	Fruit	Apple sauce				Fruit (Apple)							
Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable	Cracker	Vegetable
Peanut Butter	Cheese Sprd	Jam	Cheese Sprd	Jelly	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Jalapeno Chse Spr	Peanut Butter	Peanut Butter	Peanut Butter	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Chse Spr	Cheese Sprd	Cheese Sprd	Peanut Butter	Peanut Butter	Peanut Butter	Jelly	Peanut Butter	Cheese Sprd
	Pound cake	Cookies chcv	Pound cake	Pound cake	Fig Bar	Shrtbrd	Fudge Brownie		Fig Bar							Fudge Brownie	Pound cake	Pound cake	Pound cake	Pound cake	Cookies chcv	Pound cake	Toasters Pastry
Bev Base	Bev Base	Bev Base																					
sugar	sugar	sugar																					
Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt	Acc Pkt
B**	A**	B	C**	D**	E**	A	A	C	D	C	D	D	D	B	C	C	D	A	B	C	E	A	D

\* M&Ms plain, Charms, Skittles or Jolly Rancher candy

\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum, Tabasco  
 Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco, candy (Tootsie Roll or vanilla caramels)  
 Acc Pkt C: Lemon tea w/sugar, chewing gum, Tabasco  
 Acc Pkt D: Lemon tea w/sugar, apple cider, chewing gum, Tabasco  
 Acc Pkt E: Tea bag, cream, sugar, chewing gum, Tabasco



# APPENDIX J Menus for Meal, Ready-to-Eat XIX

Menu 1	Menu 2	Menu 3	Menu 4	Menu 5	Menu 6	Menu 7	Menu 8	Menu 9	Menu 10	Menu 11	Menu 12	Menu 13	Menu 14	Menu 15	Menu 16	Menu 17	Menu 18	Menu 19	Menu 20	Menu 21	Menu 22	Menu 23	Menu 24
Beef- Steak	Pork Chop Noodles	Beef Teriyaki	Ham Slice	Grilled Chicken	Chicken Noodles	Chicken Salsa	Chicken Rice	Beef Stew	Chili Mac	Pasta w/veg	Bn&Rce Burrito	Cheese Tortellini	Pasta Alfredo	Franks	Chicken Thai Sca	Beef Ravioli	Turkey Potatoes	Beef Mushrm	Spag Mt Sca	Chicken Stw	Chicken PK Chow	Chicken Cavatelli	Meatloaf
Mexican Rice	White Rice	White Rice	Noodles in Sca	Mexican Rice	Mexican Rice	Mexican Rice	Mexican Rice								White Rice	White Rice	White Rice	White Rice		Chw Mein Nd	Noodles in Sca		
	Fruit (Apple)									Fruit	Fruit	Apple sauce	Fruit			Fruit (Apple)							
Cracker	Vegetable Cracker	Cracker	Vegetable Cracker	Cracker	Wht snck Bread	Cracker	Cracker	Cracker	Vegetable Cracker	Cracker	Vegetable Cracker	Cracker	Vegetable Cracker	Vegetable Wht snck Bread	Cracker	Cracker	Vegetable Cracker	Cracker	Vegetable Cracker	Cracker	Vegetable Cracker	Cracker	Vegetable Cracker
Peanut Butter	Cheese Sprd	Jam Chse Spr	Jalapeno Chse Spr	Jelly	Peanut Butter	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Peanut Butter	Peanut Butter	Peanut Butter	Peanut Butter	Peanut Butter	Peanut Butter	Jalapeno Chse Spr	Cheese Sprd	Peanut Butter	Jelly	Cheese Sprd	Cheese Sprd	Peanut Butter	Jam Chse Spr	Jalapeno
	Pound cake	Pound cake	Pound cake	Pound cake	Fig Bar	Shrtbrd Cookies	Fudge Brownie		Pound cake							Fudge Brownie	Cookies chcv			Pound cake	Pound cake	Pound cake	Toaster Pastry
Beef Jerky	Cheese pb crackrs							Peanuts		Granola bar	Frt-filled bar	Granola bar	Gmla br Frt-filled br	Potato Stick	Nut raisini Mix		Choc Sport bar		Toasted pb crackrs	Pretzels			
	Hard Candy**							Candy*		Peanut bar	Peanut bar	Hard Candy**						Candy*	Candy*			Candy*	
								Cocoa	Cocoa										Cocoa	Cocoa			
Bev Base	Bev Base	Bev Base												Bev Base			Bev Base	Bev Base			Bev Base	Bev Base	Bev Base
sugar	sugar	sugar												sugar			sugar	sugar			sugar	sugar	sugar
Acc Pkt B***	Acc Pkt A***	Acc Pkt A	Acc Pkt C***	Acc Pkt D***	Acc Pkt D	Acc Pkt A	Acc Pkt A	Acc Pkt C	Acc Pkt E***	Acc Pkt C	Acc Pkt D	Acc Pkt C	Acc Pkt D	Acc Pkt B	Acc Pkt E	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt A	Acc Pkt C	Acc Pkt C	Acc Pkt A	Acc Pkt D

\* M&Ms plain or Skittles candy

\*\* Charms or Jolly Rancher candy

\*\*\* Acc Pkt A: Coffee, cream, sugar, chewing gum, Tabasco

Acc Pkt B: Coffee, cream, sugar, chewing gum, Tabasco, candy (Tootsie Roll or vanilla caramels)

Acc Pkt C: Lemon tea w/sugar, chewing gum, Tabasco

Acc Pkt D: Lemon tea w/sugar, apple cider, chewing gum, Tabasco

Acc Pkt E: Tea bag, cream, sugar, chewing gum, Tabasco

# APPENDIX K Summary of Nutrient Values for Meal, Ready-to-Eat XIX

	Water	Energy	Prot	Fat	Carb	D Fiber	Ash	Ca	Fe	Mg	P	K	Na	Zn	Cu	Cl
MENU																
MENU 1	172.40	1162	48.72	48.30	138.74	6.92	8.76	235	7.95	154	701	1179	2190	8.80	0.655	5.7
MENU 2	304.28	1277	35.12	54.09	166.53	3.04	9.29	466	5.83	68	593	683	2547	5.04	0.637	5.5
MENU 3	269.44	1325	34.03	41.18	205.30	5.25	10.28	189	6.03	82	443	1565	2937	5.08	0.572	7.5
MENU 4	223.04	1219	42.09	58.91	134.12	3.93	11.16	499	6.59	97	928	983	3046	5.01	0.780	6.5
MENU 5	176.71	1182	30.89	34.39	191.22	5.80	6.92	289	6.24	102	675	1165	1472	2.33	0.770	3.7
MENU 6	210.01	1157	38.76	44.96	160.24	9.64	8.03	325	6.17	163	636	1129	1806	3.26	0.742	4.3
MENU 7	290.61	1239	46.39	54.37	148.17	10.16	10.42	339	7.01	189	787	1781	2088	3.31	0.797	5.4
MENU 8	188.03	1232	53.76	56.01	137.64	5.76	6.29	288	7.35	167	623	1037	1483	4.29	0.995	3.4
MENU 9	200.03	1213	49.19	56.39	135.32	7.95	9.53	443	7.01	148	878	1340	1923	7.49	0.959	4.0
MENU 10	185.87	1221	44.35	58.64	138.55	9.46	8.25	354	8.44	172	688	1500	1869	6.51	1.031	4.1
MENU 11	292.01	1161	31.79	52.20	154.07	14.46	7.85	207	6.58	211	520	1068	1716	4.11	0.830	4.2
MENU 12	176.05	1226	30.18	50.79	174.46	12.43	6.37	540	7.48	173	474	901	1431	4.59	0.683	3.3
MENU 13	287.76	1117	27.81	37.98	173.81	10.47	7.16	255	6.21	158	453	826	1644	3.44	0.748	4.0
MENU 14	288.90	1217	29.34	45.82	182.11	11.75	7.36	546	7.53	174	521	910	1696	5.46	0.616	4.0
MENU 15	84.23	1179	35.26	64.32	123.97	6.07	8.98	227	6.35	136	651	1085	2084	6.39	0.618	4.7
MENU 16	302.51	1314	44.95	71.67	131.78	9.89	11.63	525	4.82	174	908	1324	2817	5.09	0.873	6.5
MENU 17	305.73	1356	32.41	58.68	184.92	8.23	10.27	469	8.74	134	764	1145	2453	4.58	0.995	5.1
MENU 18	292.84	1322	51.49	48.82	179.40	11.18	8.58	425	6.50	192	768	1221	1820	4.06	0.762	4.1
MENU 19	272.41	1212	38.07	39.55	156.17	4.77	7.93	219	6.34	76	473	805	1885	7.87	0.548	4.6
MENU 20	190.83	1303	35.62	63.03	156.17	6.73	10.71	622	6.53	120	830	1256	2410	5.37	0.739	5.3
MENU 21	208.97	1258	39.77	54.87	156.01	6.27	9.70	423	7.49	110	867	1142	2351	3.82	0.910	4.9
MENU 22	192.04	1345	36.14	66.70	158.07	6.93	7.86	304	6.59	131	446	832	2000	4.38	0.796	5.0
MENU 23	188.62	1272	26.85	41.15	202.89	4.14	5.89	211	6.14	83	430	564	1378	2.41	0.678	3.4
MENU 24	309.16	1277	32.10	54.57	168.56	2.51	9.94	518	7.25	78	621	619	2928	4.63	0.468	6.4
Average	233.85	1241	38.13	52.39	161.68	7.66	8.72	372	6.80	137	653	1086	2075	4.89	0.758	4.8
Std Dev	60.63	65	7.83	9.51	22.97	3.14	1.61	131	0.87	42	161	296	509	1.61	0.149	1.1

	Vit C	Thiamin	Ribo	Niacin	Vit B6	Folate	Vit B12	Vit A tot	Carotene	Vit E	SFA	MFA	PFA	Chol
MENU														
MENU 1	85.7	1.967	1.013	18.187	2.47	123	0.89	2874	61.45	5.6	12.85	20.52	10.24	79
MENU 2	66.3	2.186	0.936	7.401	1.96	91	2.00	3567	32.44	3.7	20.97	23.60	5.48	177
MENU 3	39.2	1.053	1.280	11.460	0.76	144	2.00	436	22.52	4.5	10.04	19.29	8.17	54
MENU 4	79.4	3.188	1.144	9.451	3.22	115	1.18	7191	41.89	4.5	21.66	25.98	7.69	195
MENU 5	88.3	2.149	1.037	16.203	2.31	117	0.44	4001	61.89	2.8	10.05	16.30	5.66	110
MENU 6	108.8	2.451	0.654	14.611	3.27	114	0.40	5711	1684	5.5	10.91	20.50	10.72	63
MENU 7	98.8	3.241	1.134	21.442	4.00	146	0.82	6809	1796	7.6	12.38	25.06	13.34	57
MENU 8	71.5	1.825	0.886	18.287	2.18	107	0.50	2577	723	7.8	14.01	27.51	11.18	124
MENU 9	94.2	2.954	1.093	13.521	3.56	122	2.12	9842	346.24	5.9	21.57	23.64	7.28	110
MENU 10	84.6	2.984	1.157	14.206	3.84	140	2.18	6964	1826	7.5	16.21	27.83	10.28	109
MENU 11	81.9	2.127	0.846	13.652	2.36	130	0.00	5753	1044	10.4	9.32	22.24	13.83	10
MENU 12	99.2	2.441	1.466	18.914	2.86	175	0.00	4070	1034	8.9	9.94	21.53	12.65	10
MENU 13	341.6	2.050	0.848	10.817	2.24	145	0.08	2808	743	7.7	7.37	17.46	10.56	7
MENU 14	99.2	2.414	1.512	16.495	2.79	167	0.12	5010	1161	8.4	11.37	20.59	10.63	25
MENU 15	85.1	1.250	0.478	13.990	1.78	82	1.08	2400	693	6.2	20.79	27.92	11.19	72
MENU 16	79.4	2.996	0.973	13.678	3.48	160	0.56	7260	63.22	7.3	21.98	30.22	15.29	93
MENU 17	79.4	3.134	1.249	7.558	3.25	140	1.02	6956	2007	5.5	24.08	25.18	5.36	112
MENU 18	113.9	2.220	0.761	16.211	2.62	81	0.83	3326	912	7.8	14.88	19.87	11.16	76
MENU 19	51.7	1.051	0.802	9.730	1.03	108	2.84	438	86	3.0	13.93	16.99	4.81	90
MENU 20	94.2	3.036	1.055	9.775	3.28	119	1.98	7417	2022	4.2	27.01	26.66	4.54	103
MENU 21	79.4	3.046	1.270	14.044	3.45	152	1.33	9887	2263	3.1	21.67	24.01	5.54	152
MENU 22	71.5	2.206	0.906	12.443	2.25	114	0.40	2600	730	6.4	16.59	31.49	14.29	108
MENU 23	53.9	1.040	0.842	9.937	0.76	127	0.58	230	40	3.7	12.32	21.09	4.94	150
MENU 24	90.4	4.254	1.056	8.086	1.90	165	1.81	4310	1209	4.1	19.90	21.98	8.49	105
Average	93.2	2.386	1.017	13.337	2.56	128	1.13	4677	1220	5.9	15.91	23.23	9.31	91
Std Dev	55.7	0.803	0.242	3.811	0.90	26	1.00	2719	698	2.1	5.52	4.09	3.33	50

